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Assessing Student Comprehension in Introductory Biology: A Comparison of Free-Response and Multiple-True/False Exam Formats

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BACKGROUND

- Goal: Determine the advantages and disadvantages of Free-Response and Multiple-True/False question formats for assessing student comprehension in introductory biology.
- Question format is an important consideration when designing instruments to assess student comprehension
- Instructors must decide how to effectively test a large group of students in lecture-style courses.
- *Free-response (FR) question*: a question prompt which students respond to with essay-style answers
- *Multiple-True/False (MTF) question*: an opening question stem with accompanying statements to be marked as either true or false

PREDICTIONS

- Students may be more likely to avoid or omit topics they have a poor understanding of when faced with a FR question.
- MTF questioning enables instructors to probe specific misconceptions that may not be addressed by students in open-ended responses.

METHODOLOGY & TIMELINE

Fall 2014 — Students answer FR prompts on homework assignments

Summer 2015 — Code for most common correct & incorrect student ideas for each FR prompt.

Fall 2015 — Create 1 FR and 4 MTF statements based on most common ideas for student exam.

Fall 2015 — Students complete an exam that addresses the same ideas in either FR or MTF format.

Spring 2016 — 4 MTF statements used to assess whether FR answer omits, correctly, or incorrectly addresses each prompt.

A eukaryotic cell's DNA is housed in a nucleus. How is the information contained in the nucleus exported and used to guide a cell's activities?

T/F **1.** mRNA is synthesized in the nucleus from a DNA template.
T/F **2.** mRNA is exported from the nucleus into the cytoplasm.
T/F **3.** Proteins are synthesized by ribosomes in the nucleus from an mRNA template.
T/F **4.** Proteins are transported to the proper location in the cell for their function.

(2) Correct — (1) Correct

"DNA is transcribed into mRNA and is transported out of the nucleus. When the new protein leaves the nucleus, it is sent to the cytosol."

(3) Incorrect — *(4) Omitted

RESULTS

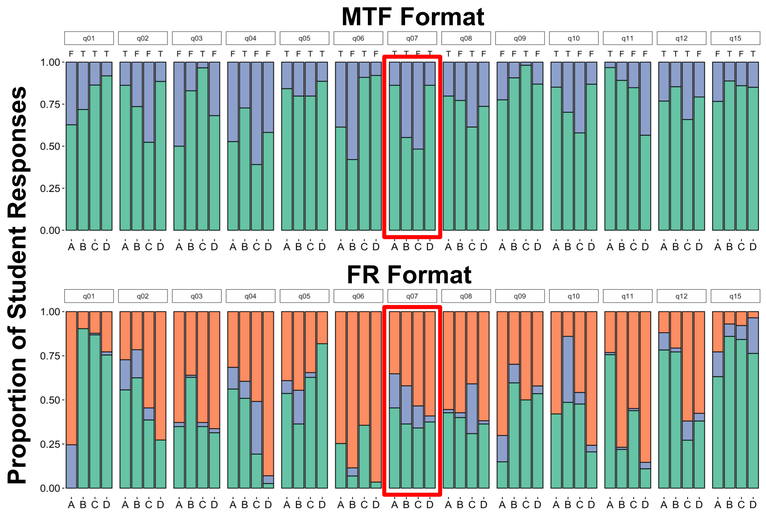

Figure 1. Comparison of answers for all inverted questions.

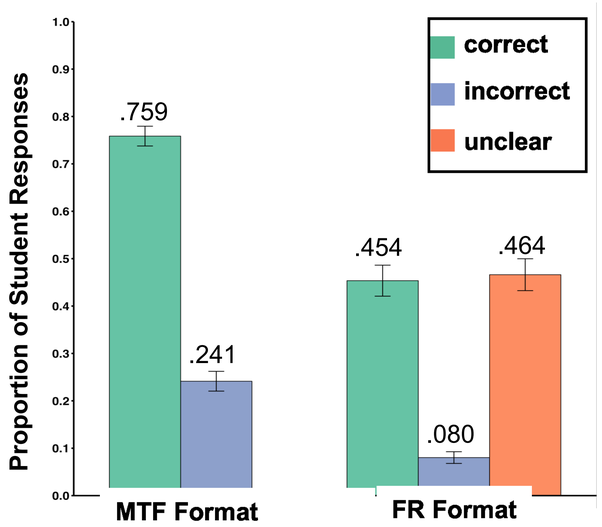

Figure 2. Aggregated comparison of answers for inverted questions.

MTF questions showed higher rates of correct[1] and incorrect[2] conceptions.
FR responses often were unclear with respect to student understanding of specific ideas.

[1](t=10.024, df=51, p<0.001), [2](t=8.095, df=51, p<0.001)

THINGS TO CONSIDER

	MTF	FR
+	Provides instructors with clear answers that can be used to gauge student comprehension	Gives students the opportunity to articulate their thoughts & allows synthetic thinking
−	Students can use cues in the statements to select correct answer without fully comprehending the concept	Answers can be vague or off-topic Cannot gauge student comprehension of content they omit from their answer

- Regardless of question format, the quality of a question will affect its ability to evoke the desired answer and accurately gauge student comprehension.
- Instructors should consider using a variety of question formats in order to gain a more complete understanding of students' comprehension of topics.

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